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Effects of Fire on Sagebrush and Bitterbrush[1]

Carlton M. Britton and Robert G. Clark

Community Description

The sagebrush-bunchgrass region of the Great Basin covers at least 39 million hectares (USDA Forest Service 1936). The largest contiguous area lies in eastern Oregon, southern Idaho, southwestern Wyoming, northern Utah, and northern Nevada (Vale 1975). Most of this vegetative type occurs below the pinyon-juniper zone, but in the absence of a pinyon-juniper zone, sagebrush-bunchgrass vegetation will border curlleaf mahogany (Cercocarpus ledifolius), Gambel oak (Quercus gambelii), ponderosa pine (Pinus ponderosa), or Douglas-fir (Pseudotsuga menziesii). Sagebrush-bunchgrass communities also can occur above the pinyon-juniper zone in the Great Basin (Billings 1951) and throughout most mountain plant communities in the Rocky Mountain and Intermountain regions (Beetle 1960).

Sagebrush-bunchgrass vegetation is found at elevations from 610 to 2,130 m. This zone can occur below 300 m in south-central Washington and British Columbia and mixes with all vegetation zones to varying degrees up to 3,000 m (Beetle 1960), including the subalpine herbland. Where a sagebrush-bunchgrass prevails below 2,100 m, annual precipitation varies from 20 to 50 cm (Tisdale et al. 1969). Soil texture varies from loamy sand to clay. Most soils are derived from basalt, although extensive areas have soils derived from rhyolite, loess, lacustrine, alluvium, and limestone (Tisdale et al. 1969). Interactions of soil, precipitation, and elevation result in many distinct combinations of sagebrush-bunchgrass dominated communities.

Three subspecies of big sagebrush dominate the sagebrush-bunchgrass region. These are basin big sagebrush (Artemesia tridentata ssp. tridentata), Wyoming big sagebrush (A.t. ssp. wyomingensis), and mountain big sagebrush (A.t. ssp. vaseyana). Basin big sagebrush (1 to 5 m tall) and Wyoming big sagebrush (0.4 to 0.8 m tall) are the dominants from 610 to 2130 m elevations, with the latter being the most drought tolerant (McArthur et al. 1974). Basin big sagebrush occupies a 25 to 40 cm precipitation zone on deep well-drained alluvial soils. Wyoming big sagebrush occupies a 20 to 30 cm precipitation zone on shallow soils (Tisdale et al. 1969). Mountain big sagebrush (0.75 to 1.25 m tall) is the most mesic subspecies and can be found at elevations from 1500 to 3050 m where precipitation varies from 35 to 50 cm per year (McArthur et al. 1974).

Other species of sagebrush in decreasing order of economic importance are low sagebrush (A. arbuscula), three-tip sagebrush (A. tripartita), black sagebrush (A. nova), silver sagebrush (A. cana ssp. viscidula and ssp. bolanderii), alkali sagebrush (A. longiloba), Bigelow sagebrush (A. bigelovii), and scabland sagebrush (A. rigida) (Tisdale et al. 1969, McArthur et al. 1974). The first three species generally grow below 1830 m elevation although they can occur at higher elevations. Low sagebrush occurs on shallow soils or soils with a restrictive B horizon, mostly in southern Idaho, Nevada, southeastern Oregon, and northeastern California (Fosberg and Hironaka 1964). Three-tip sagebrush occurs east of this region on mesic or dry soils in a precipitation zone of 25 to 40 cm. Black sagebrush is usually associated with calcareous soils on dry sites, but can occur on mesic sites of the Douglas-fir zone in eastern Idaho. Silver sagebrush occurs primarily in spring-flooded bottomlands and at high elevations where snow drifts. All species except three-tip sagebrush and silver sagebrush are nonsprouters. Three-tip sagebrush is a weak sprouter, and silver sagebrush is a strong sprouter.

Major shrubs associated with big sagebrush include horsebrush (Tetradymia spp.), rabbitbrush (Chrysothamnus spp.), and broom snakeweed (Xanthocephalum sarothrae). Spiny hopsage (Grayia spinosa) and mormon tea (Ephedra nevadensis) are sporadically present in the lower rainfall areas (Wright et al. 1979).

Antelope bitterbrush (Purshia tridentata) is one of the most widely distributed western shrubs. Hormay (1943) estimated its range at 138 million ha in 11 western states and southern British Columbia. Antelope bitterbrush is found from northern Arizona and New Mexico northward to southern British Columbia, and from the Cascade-Sierra Mountain Range eastward to western Montana, Wyoming, and Colorado. It occurs at elevations from 305 m in British Columbia to 3505 m in California (Hormay 1943; Nord 1965).

Bitterbrush can grow in pure stands (Stanton 1959) but more commonly in association with various genera of trees, shrubs, forbs, and grasses. For example, Franklin Dyrness (1969) described 18 habitat types in Oregon in which bitterbrush was a major component.

Bitterbrush grows on a wide variety of soils. In California, Nord (1965) reported stands on soils developed from granitic, basaltic, rhyolitic, or pumiceous parent

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materials, or on sedimentary sandstone and shale rock. In general, bitterbrush is most frequently found on young, deep to very deep, coarse-textured, well-drained soils (Driscoll 1964, Nord 1965). Bitterbrush is also a pioneer species on recent volcanic deposits in Idaho (Eggler 1941) and California (Nord 1965) and codominant with ponderosa pine on a 27-year-old mud slide in California (Dickson and Crocker 1953). Nord (1963) reported that bitterbrush often invades disturbed areas long before other plants appear and for many years may provide the only form of soil cover. Therefore, the case could be made that bitterbrush is a seral species. Management of bitterbrush as a climax species could hasten its demise in a community.

Fire Effects on Sagebrush

Big sagebrush is killed easily by fire (Blaisdell 1953). It is relatively unimportant how fast the fire moves, how hot the fire is, or what the fire intensity is. The only critical parameter is that foliage be exposed to a minimum temperature of 90°C for a period of at least 30 sec. Therefore, the effect of fire can be briefly stated: if a fire front passes through an area, the sagebrush will be killed.

A major point of concern is the length of time an area will stay free of sagebrush. On the upper Snake River Plains of Idaho, Blaisdell (1953) found that after 12 years there was only a 10% return of sagebrush after fire. However, after 30 years had passed, Harniss and Murray (1973) found sagebrush had returned to the preburn condition. Many factors influence the rate of sagebrush reinfestation on treated areas. If a seed reservoir is available, the most important factor is the pattern and amount of precipitation following the burn. If precipitation is not conducive to germination and establishment of sagebrush, the burned area may be relatively free of sagebrush for many years.

One problem facing range managers is picking a suitable area to burn. Although there are many aspects to consider prior to applying a fire treatment, one must select an area that will burn. The proper combination and amount of fuel must be present or the area will be extremely difficult to burn. An area with 7 to 10% canopy cover of sagebrush is difficult to burn and will not result in a significant increase in herbaceous yield. Figure 1 presents a fuel model that allows a manager to determine if a suitable amount of sagebrush and fine fuel are present to support a safe prescribed fire (Britton et al. 1981). The curve represents the relationship between sagebrush canopy cover and herbaceous fuel at which safe and successful prescribed burns can be expected. This relationship will hold when wind is 12 to 24 km/hr, relative humidity is 15 to 20%, and air temperature is 20 to 27 C. If burns are conducted with stronger winds and higher air temperatures at lower humidities, the curve will shift to the left. The curve will shift to the right when burns are conducted with lower winds and air temperatures in conjunction with higher humidities. As a general rule, at least 20% canopy cover of sgebrush and 300 kg/ha of herbaceous fuel is needed to ensure a successful burn.

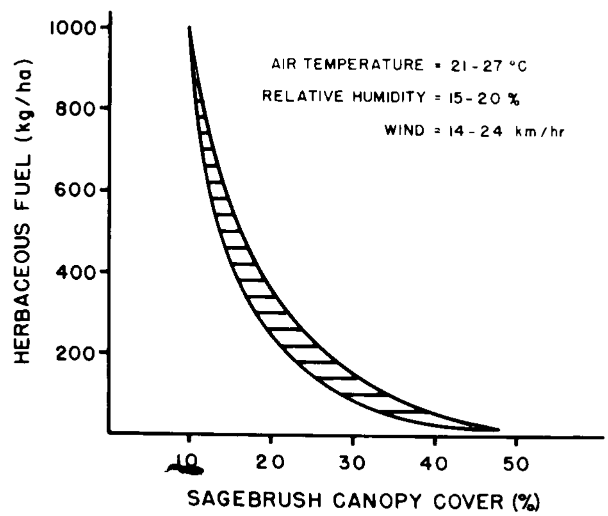

Figure 1. Fuel model of sagebrush canopy cover and herbaceous fuel load. Curve represents proportions of the two fuels where successful burns can be expected for the given conditions.

Canopy cover of big sagebrush and herbaceous fuel is greater on more productive sites. Therefore, subspecies of sagebrush can be used as an initial evaluation of site suitability. Mountain big sagebrush communities are burned most easily. Basin big sagebrush is intermediate and Wyoming big sagebrush is most difficult to burn. These differences are not related to any specific differences in individual plants but rather to sites where the subspecies occur. Mountain big sagebrush and basin big sagebrush typically occupy deeper soils on sites that receive more moisture than Wyoming big sagebrush. Thus, the better sites are capable of supporting greater plant densities. This results in more sagebrush canopy cover and herbaceous fuel. In sagebrush-bunchgrass communities, the more fuel available, the easier it is to conduct safe and effective burns.

Effects of Fire on Bitterbrush

Literature on bitterbrush has recently been summarized (Clark and Britton 1979). In this summary, 135 articles published during the period 1967-1978 were annotated, and 233 articles published previously were listed.

Summarizing this mass of literature in his thesis, Clark (1979) gave the following description of the effect of fire on bitterbrush. Possibly because of bitterbrush's extensive range, climatic and environmental conditions under which it grows, its response to burning is highly variable. Although most bitterbrush reproduces from seed (West 1968) it is commonly felt that fire destroys bitterbrush by removing both the existing stand and seed source. Most reports discussing the response of bitterbrush to burning are results of wildfires and are not well documented with respect to soil textural characteristics, soil moisture, phenological stage of development, weather conditions, or other environmental conditions which may influence post-fire recovery.

In California, Nord (1965) reported highly variable post-burn recovery, where 5 of 13 wildfires resulted in at least 5% sprouting while one burn exceeded 25% sprouting. Hormay (1943) noted that the only instance in which substantial sprouting (over 25%) occurred was a January wildfire in northeastern California. Hormay stated that hundreds of thousands of hectares of bitterbrush have been destroyed by fire. Countryman and Cornelius (1957) reported a complete absence of bitterbrush regeneration six years after a wildfire although it constituted 91% of the vegetative cover adjacent to the burn. Leopold (1950) emphasized the highly variable response by noting that in the Truckee River Canyon of eastern California logging and recurrent fires stimulated extensive growth of bitterbrush, but a few kilometers toward Reno fires seemed to eliminate bitterbrush.

Southern Idaho frequently is described as an area where bitterbrush sprouts well following fire. Blaisdell (1950, 1953) reported that burning destroyed sagebrush but bitterbrush sprouted. The year following burning, 49, 43, and 19% of burned plants sprouted on light, moderate, and heavy burns, respectively. These results occurred on basaltic soils in a 41 cm precipitation zone. Similar results were obtained at the U.S. Sheep Station near Dubois, Idaho where precipitation is 28 cm. At Dubois, nearly all the plants sprouted after a small burn of light intensity in the fall of 1945, but only 25% sprouted on a large burn of heavy intensity in the fall of 1947. Blaisdell and Mueggler (1956) burned or severed bitterbrush plants 5 cm above ground level in Idaho. They found that 50 and 72%, respectively, of burned and severed plants sprouted, and that sprouting occurred as late as 13 months after treatment. Also, mortality was high on sprouted plants. Of the burned plants that sprouted, 33% died within 12 months compared to 21% death among the severed plants. Clark et al. (1982) burned and clipped bitterbrush during fall and spring, under different soil moisture conditions on two sites in eastern Oregon. Sprouting after treatment was similar on the two sites, and burning resulted in greater mortality than clipping. Artificially watering plants before or after burning did not result in substantial reduction in mortality. Over-winter mortality of sprouts was high.

Driscoll (1963) found in Oregon that sprouting ability was related more to soil factors than to burn intensity. On northerly slopes, stands of bitterbrush found on loose, coarse-textured, nonstony soils without cinders or pumice had the highest frequency of sprouting. In one such area, 80% of the burned plants sprouted. Driscoll also noted that bitterbrush on these sites frequently layered, and plants which sprouted did so from the layer but never from the parent plant. Weaver (1957) observed in the ponderosa pine zone of Oregon, bitterbrush rapidly and heavily invaded after logging but was readily killed by fire. On areas where it dominated ground cover, it had not reestablished 18 months after wildfire.

Less information on burning response is available from other areas. In central and northern Utah, Blaisdell and Mueggler (1956) observed only limited sprouting. Daubenmire (1970) found bitterbrush in Washington nearly always is killed by steppe fires. In the Great Basin, Billings (1952) generalized that bitterbrush is eradicated by fire since it rarely rootsprouts in that region and its seeds are not particularly mobile.

The 1982 Symposium on Research and Management of Bitterbrush and Cliffrose in Western North America, held in Salt Lake City, presented many interesting viewpoints and some new data. Rice (1982) presented a fresh review of often cited literature on bitterbrush and concluded fire should be used in bitterbrush communities. Although some damage will occur, the uneven-aged stands that result are desirable. Contrary to other work in Washington, Driver (1982) observed 40 to 100% sprouting from spring burns in the central portion of the state. In central Oregon along the eastern edge of the southern Cascades, Martin (1982) reported bitterbrush mortalities of 77 to 100% for prescribed burns. Nineteen of 22 burns had mortalities higher than 97%. However, bitterbrush seedlings established quickly producing uneven-aged stands.

Conclusions on Bitterbrush

In reviewing the wealth of information on bitterbrush, no clear-cut answers emerge. The only consistent trend evident is the high level of variation in response. The following are trends that generally hold:

1. Spring burns are generally less damaging contrasted to fall burns.
2. Summer burns are very damaging.
3. Good soil moisture at the time of spring burning and for the first growing season is beneficial.
4. There is a tendency for plants to respond favorably at higher elevations.
5. Decumbant growth forms respond better to fire compared with columnar forms.
6. There is no evidence that fire intensity influences bitterbrush sprouting. However, fuel consumption

appears to have some correlation. Where consumption of fuel is high, mortality of bitterbrush is generally high, and seedling establishment is increased. Where consumption is low, bitterbrush mortality is reduced, and seedling establishment is reduced.

A final recommendation is to burn a small plot adjacent to the major burn being planned. This pilot burn should be at least one ha in size and contain a minimum of 50 bitterbrush plants that are marked with steel stakes. The burn should be conducted under the same prescription as the planned major burn. Marked plants should be observed closely for at least one growing season and through one winter. Measure everything accurately and in sufficient numbers to yield useful data. Although this technique will delay the major burn for at least 12 months, it will give a reasonable estimate of bitterbrush response for the area of interest.

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